(54) Matrix display device

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(57) Scope of Claim

1. A matrix display device in which a plurality of column electrodes cross a plurality of row electrodes, the row electrodes are selectively driven, a signal showing each pixel corresponding to a display position of each selected row electrode is applied for driving to each of the plurality of column electrodes which correspond thereto,

        wherein the plurality of row electrodes are divided into a plurality of groups;

        wherein corresponding row electrodes in these groups are connected to each other and driven at the same time;

        wherein the each column electrode is divided into a plurality of column electrode groups per row electrode in an extending direction;

        wherein a signal showing corresponding pixels to display positions of a

plurality of row lines which are selectively driven per each column electrode group is applied for driving at the same time.

Detailed Description of the Invention

This invention relates to a matrix display device which displays information by allowing a liquid crystal or a light emitting diode to emit light using electrodes in matrix.

As information display systems using a liquid crystal, a light-emitting diode or the like, there are a static display type, that is, a dot matrix structure in which an electrode is taken out to correspond to each one pixel, and a dynamic display type, that is, a cross matrix structure including orthogonal X and Y electrode groups. As shown in FIG. 1, in the dot matrix structure, display information transmitted from an information source 1 such as an external electronic computer is input to an input device 2 through a transmission path, and signal processing such as code conversion is conducted here, and the converted information is memorized in a main memory device 3. The information memorized in the main memory device 3 is converted to a display pattern in a character signal generator 4 and then, transferred to a driver circuit 5. In the driver circuit 5, each electrode arranged in matrix to correspond to each pixel in a display panel 6 is driven at the same time. In this device, a static voltage is applied to one arbitrary pixel electrode, so that a driving condition (for example, a luminance or the like) sufficient for driving the display element can be obtained; however, the same number of driver circuits as the pixels are necessary, which leads to less economical because of the increase in the number of pixels. Note that reference numeral 7 denotes a control device for the input device, the main memory device and the driver circuit.

In a conventional cross matrix structure, as shown in FIG. 2, the information memorized in the main memory device 3 is converted to a display pattern in the character signal generator 4, and is memorized in a buffer memory of a column driver circuit 8 per row of the display screen. Output of each buffer memory of the column driver circuit 8 is supplied to each of column electrodes Y_1, Y_2, ...Y_n. Row electrodes X_1, X_2,...X_n crossing the column electrodes Y_1, Y_2, ...Y_n are sequentially driven by a row driver circuit 9. Information memorized in the buffer memory is displayed per row. This display is called a line sequential scanning method. Note that the control for the character signal generator 4 by the control device 7 in this case is slightly different from that of FIG. 1.

In this cross matrix structure, when a liquid crystal is used as a display element, rising time of the liquid crystal is very slow due to the characteristic of the liquid crystal material itself, and in general, it is necessary to have a sufficiently long driving scan

cycle. Although the scan cycle is set long depending on the increase in the number of line pixels, when this cycle is equal to or longer than an afterglow time for human eyes, flickers are recognized to the eyes. As a countermeasure to this defect, the following two methods are given: (I) to slow down the rising time of the liquid crystal, that is, to lengthen the afterglow time; and (II) to shorten an interval of non-driving time in one arbitrary row. However, the former is determined depending on the characteristic of the material, and thus, is a problem which cannot be solved by a change of the driver circuit. After all, there are no improvement methods other than selecting the latter. In addition, when the plane scan cycle is within the afterglow time, the increase in the number of line pixels causes reduction of the average luminance of the screen. In order to prevent this reduction, a method is devised, in which a drive pulse amplitude is enlarged, but it is almost ineffective, since luminance characteristics of the liquid crystal tend to be saturated in accordance with the increase in the amplitude of an applied voltage.

On the other hand, when a light emitting diode is used for a display element, it is general that the rising time of the material itself is very fast, and it is not difficult to set the scan cycle within the afterglow time for human eyes. In addition, since luminance characteristics also depends on voltage and current, reduction in the average luminance due to the increase of the number of line pixels can be prevented to some extent by enlarging a drive pulse amplitude. However, in general, there is a risk that a semiconductor element having a junction surface, such as a diode, is broken instantaneously or the life of the element itself is deteriorated extremely due to a peak voltage current. If an enough margin is provided for the instantaneous duration, life, or the like, new problems such as cost increase of the element and the increase in the size are caused, and these problems influence the total number of pixels, which is a big defect.

In this invention, a plurality of row electrodes are divided into a plurality of groups, row electrodes corresponding to each group are driven at the same time, a column electrode is divided in a longwise direction in each row electrode group, and a signal indicating a pixel at the position of each row electrode which is driven now in the group, is applied to a corresponding column electrode in the divided column electrode groups in each row electrode group. In this manner, a plurality of line pixels in one screen are made to emit light for display at the same time, and the drive cycle of each line pixel is shortened, and the increase of the number of pixels, and reduction of luminance and life can be solved economically in the case of using a line sequential scan method.

For example, as shown in FIG. 3, row electrodes X_1, X_2...X_m, X_1', X_2'...X_m' are divided into two row electrode groups Xa and Xb including X_1, X_2...X_m, and X_1', X_2'...X_m' which are consective. The row electrodes X_1, X_1', X_2, X_2'...and X_m, X_m' corresponding to each other, in these row electrode groups Xa, Xb are connected to each other, and these are sequentially driven by the row driver circuit 9.

Each column electrode is divided in the longwise direction in row electrode group Xa and Xb to obtain a column electrode group Ya including Y_1, Y_2...Y_n and a column electrode group Yb' including Y_1', Y_2'...Y_n'. Therefore, the display panel 6 is divided into two regions, a region of the row electrode group Xa and the column electrode group Ya, and a region of the row electrode group Xb and the column electrode group Yb. Each electrode of the column electrode group Ya is connected to a corresponding one of the first column driver circuit 8a, and each electrode of the column electrode group Yb is connected to a corresponding one of the second column driver circuit 8b. Note that at least one of the row electrode and the column electrode is transparent.

A signal from the character signal generator 4, a pixel signal for each one row corresponding to row electrodes which are selectively driven by the row driver circuit 9, for example, line pixels of X_1 and X_1' are memorized in each buffer memory of the first column driver circuit 8a and the second column driver circuit 8b through the gate circuit 10. The column electrode Y_1, Y_2...Y_n and Y_1', Y_2'...Y_n' of the column electrode groups are each driven, and line pixels corresponding to the selected row electrodes X_1, X_1' are used for displaying at the same time. Next, the row electrodes X_2, X_2' are selectively driven, and in response to this, a buffer memory of each column driver circuit 8a and 8b is rewritten so that drive display is conducted in a similar way. Hereinafter, sequence drive is conducted in a similar way, and when one screen is displayed, driving of first row electrodes X_1 and X_1' are repeated again.

In such driving, with respect to a width W_1 and a cycle T_1 (FIG. 6A) of a drive pulse to a certain row electrode in the conventional display device shown in FIG. 2, in the device shown in FIG. 3, a width of a drive pulse for one row electrode becomes double W_2 when the cycle is the same T_1 as shown in FIG. 6B. Thus, an interval in which drive is not done is reduced for one row electrode, and duty factor which is an amount showing how much one scan cycle T1 of an arbitrary point of the display panel 6 is driven becomes twice as much as that before divining the electrode.

In the above description, the electrode is divided into two groups, in sum, it is divided into a plurality of groups, and as the number of groups is larger, the duty factor becomes large. FIG. 4 shows an example in which the row electrode is divided into

four groups Xa, Xb, Xc and Xd, and in order to correspond to these, the column electrode is divided into column electrode groups Ya, Yb, Yc and Yd, and these column electrode groups Ya, Yb, Yc and Yd are driven by driver circuits 8a, 8b, 8c and 8d, separately. Other portions which correspond to those of FIG. 3 are denoted by the same reference numerals.

As described above, by dividing and driving at the same time, luminance characteristics of the liquid crystal which are almost the same as that of a static driving method can be obtained, and a favorable screen without flickers can be obtained in which a brightness difference between driving and non-driving in an arbitrary point of the display panel can be almost ignored. In addition, when a certain level of luminance is obtained before dividing the electrode, a plane scan cycle can be shortened by dividing the electrode, and this can be closer to within the afterglow time for human eyes, and thus, a more favorable display can be obtained.

Also when a light-emitting diode is used as the display element, the duty can be increased more than a conventional one, by dividing the electrode into a plurality of groups. FIG. 5 shows a case where a row electrode and a column electrode are divided into two electrode groups Xa, Xb and Ya, Yb, respectively as an example. Portions which correspond to those of FIG. 3 are denoted by the same reference numerals. At each intersection portion of the row electrodes and the column electrodes, a light emitting diode 12 for connecting these is provided. In this manner, the average luminance of the screen can be increased without increasing the pulse amplitude of an applied drive voltage.

In the above description, the divided row electrode groups are driven at the same time as corresponding ones in the same arrangement direction; however, the correspondence can be arbitrary. For example, they may be driven at the same time to correspond to ones in the opposite arrangement direction, in other words, in FIG. 3, X_2 and X_{m}. are connected and X_2 and X_{m-1}. are connected to drive. In addition, as for the division of the row electrode, it is unnecessary that consecutive ones are made to be one group, and for example, electrodes may be divided into the first group and the second group at every other row.

As described above, in the display device of the present invention, when a large screen is used, reduction of the average luminance, flickers and the like can be prevented. A favorable image can be obtained and the number of column driver circuits is increased; however, when this is considered in light of a whole device, the increase is slight pricewise, and it can be manufactured at lower cost than a dot matrix display.

Brief Description of the Drawings

FIG. 1 is a block diagram showing a conventional dot matrix display device. FIG. 2 is a block diagram showing a conventional cross matrix display device. FIG. 3 is a block diagram showing an example of a display device according to the present invention. FIGS. 4 and 5 are each a block diagram showing another example of the device of the present invention. FIG. 6 is a voltage wavelength diagram for explanation of the present invention.

4...character signal generator, 8a, 8b...driver circuit, 9...row driver circuit, Xa, Xb...row electrode group, Ya, Yb...column electrode group.